of elementary mathematics, but like many a scrap-book it contains much valuable material. The teacher who reads this book carefully will have at hand a fact from the history of mathematics, an interesting little puzzle, a fallacy, or a pertinent illustration to drive home a truth or to break the monotony of some particularly dull moments of a recitation period. Moreover, this book is an admirable introduction to the whole subject of mathematical recreations and to the history of mathematics. It shows many of the interesting things that can be found in such books as: Ball, *Mathematical Recreations and Essays;* Ahrens, *Mathematische Unterhaltungen und Spiele;* Schubert, *Mathematische Mussestunden;* Lucas; *Récréations mathématiques;* Ball, *A Short History of Mathematics;* Cajori, *History of Elementary Mathematics.*

A few of the titles will serve to indicate the nature of the book: Multiplication at sight—a new trick with an old principle. A few numerical curiosities. Numbers arising from measurement. Present trends in arithmetic. Napier's rods, and other mechanical aids to calculations. The three parallel postulates. The three famous puzzles of antiquity. The circle-squarer's paradox. Quotations of mathematics. Magic squares. Axioms in elementary algebra. Do the axioms apply to equations? Checking the solution of an equation. Algebraic fallacies.

The last four notes are of especial value in the first-year algebra classes, since many authors of elementary algebras give little heed to the equivalency of equations. In fact, in some elementary textbooks widely used equations are given which have no solution; nevertheless, the pupils obtain an alleged solution and find their results are correct on referring to the answer book.

This book and others of like content should be in every high-school library. The author well says that amusement is one of the fields of applied mathematics. Here the interest of many pupils may be awakened, and as a result their required work in mathematics may become more pleasurable, hence more profitable.

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Electricity, Sound and Light. A Short University Course. By R. A. MILLIKAN AND JOHN MILLS. Boston: Ginn & Co., 1908. Pp. 389. Illustrated. $2.00.

This book is an attempt to secure a satisfactory articulation of the laboratory and classroom phases of instruction, and to present a complete logical development, from the standpoint of theory as well as experiment, of the subjects indicated in the title. It is designed to occupy a half-year of daily work, two hours per day, in either the freshman, sophomore, or junior year of the college or technical-school course.

It is divided into short, one-subject chapters, giving the necessary explanations and deriving the general principles involved. At the end of each chapter is an experiment or two typical of the subject of the chapter, followed by illustrative examples of the experiments. At the end of the book there are sets of questions applicable to each chapter; and these are followed by tables giving

various data, including logarithms and natural trigonometric ratios, and finally by an index.

The general division of the book into text, experiments, and problems is to be commended, as it tends to give the pupil a grasp of the subject from all points of view, and also makes him more independent of the teacher. The explanations and illustrations are exceedingly clear; many old truths are presented in new and better form; discussions are not entered into which are beyond the scope of the work or the understanding of the pupils.

The mathematics includes only trigonometry; but wisely uses the differential of certain magnitudes to indicate small quantities. For instance: "Let dQ represent the quantity of electricity which passes a given cross-section in the short element of time dt." In this way the pupil, when he reaches calculus, will have a clearer understanding of the differential, and will not be so likely to hypnotize himself into confusion. There are fewer errors in the book than usually appear in first editions, and the style is excellent.

However, I think the book is open to one serious objection, in common with most books of this type: it tends too much away from the practical. In general we have three classes of scientific books: those which are purely practical; those which are purely theoretical; and those which bridge the other two. Books intended for the instruction of the general college youth should bridge the practical and the theoretical, and if anything should tend toward the practical. There are two ways in which this undesirable tendency is shown: by ignoring practical applications, and by emphasizing principles which relate more to scientific investigations than to practical use. Mere empirical facts should not be introduced; only broad truths with scientific bases are well; but such truths may usually be illustrated by reference to ordinary contrivances, and those which may not might better be omitted.

The motor, the telephone, the microscope, are scarcely mentioned. No attempt is made to apply any of the principles to the everyday uses of sound, light, or electricity. At the same time the principles discussed most fully are the ones seldom applied in practical life. Many pages are devoted to diffraction and to polarization of light, neither of which has bearing of consequence on practical optics, while the mathematical determination of the nodal points, the optical centers, and principal foci of lenses is untouched. Probably not one per cent. of college graduates can show correctly by a diagram the principal focus of a meniscus lens; yet it is simple, scientific, and of much practical importance. Even the principles discussed are so developed as to be inapplicable by the practical man. The index of refraction is based solely upon the relation between the sines, without reference to the practical relation between the angles. The formula for focal distances is discussed at length, but without reference to the simpler formula used in practice; and similarly with the formula for branch resistances. Just as the practical electrician uses the sum of the respective currents in place of the reciprocals of the resistances, so the optometrist uses the sum of the wave powers to find the lens power instead of the sum of the reciprocals of the focal lengths. There is but a slight reference to the heating effect of currents in general, and nothing as to the similar effects of hysterisis and eddy currents; and yet the heating tendency of elec-

trical machinery is not only of the greatest practical importance, but it is full of meat for the scientific investigator.

There are some practical references, however, of much value. The motor and dynamo rule are better stated than in many engineering books. Apparently here attention is given not only to a correct statement of the rules but also to the most convenient statement to remember and to apply. In fact, the work, so far as it enters the practical field, is of great value. The writers are both educators. Mr. Millikan for years has been a leading advocate of simplicity and directness, not only in the classroom, but in books; and he has fully practiced here, as elsewhere, what he preaches. As a basis for scientific investigation the book is in all respects excellent; and for general college use it is fully the equal of any other. I feel, however, that all such books could be improved by giving more attention to practical applications.

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Essentials of Botany. By J. Y. BERGEN. Boston: Ginn & Co., 1908. Pp. 380. $1.20.

The various editions of Bergen's botanies for secondary schools are so well known that the latest edition may be best described by comparison with the others.

The *Essentials of Botany* contains work for a school year, and treats all the divisions of the subject except geography and the identification of plants.

The general morphology is so nearly the same as in earlier editions that no special notice is needed.

The physiology, which is mingled with the morphology, is antiquated and contains many errors. Erroneous or deficient statements are made, for example, concerning the sleep-movements of plants, roots turning from hard objects, carbon assimilation, ascent of sap, the demonstration of the elimination of oxygen, and the cause of the fall of the leaf. Not only is the quality of the physiology poor, but there are very many important facts omitted that even children ought to be taught. Moreover, the amount of physiology is smaller in the present volume than in earlier editions: the *Elements* had 32 experiments, and the *Foundations* 39, while the *Essentials* has but 19. The reduction in physiology is, the writer believes, a mistake, pedagogically, as well as for other reasons; for there is no other part of botany that interests pupils so much as plant-behavior.

Ecology is scattered through the general morphology and physiology, as it was originally in the *Elements,* instead of receiving separate treatment as in the three more recent manuals by the same author. This is done because the author believes that the study of ecology requires more knowledge and judgment than is possessed by the beginning pupil.

The number of pages given to the study of spore-plants stands between the extremes of earlier editions. In the *Elements* there were 26 pages, in the *Foundations* 63 pages, in the *Principles* 200 pages, and in the *Essentials* there are 85 pages. This part of the manual may be especially commended.